

FOSSILIFEROUS TERTIARY RESIN FROM ALLENDALE, VICTORIA

By E. SHERBON HILLS

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Introduction

Some years ago a very large specimen of fossil resin was presented to the Geology Department of the University of Melbourne by the Department of Mines, Victoria. Impressions of dicotyledonous leaves were visible, some with remains of the lamina of the leaf, and it was also noted that well-preserved ants, beetles and other small animals were entombed in the outer layers of the resin. This paper gives a general account of the geologically significant features of the resin lump, and the following short papers by Hickman, Oke, and Womersley describe various fossils in detail. A short account of the fossil plants based on examination by R. T. Patton, and of the millipedes by O. W. Tiegs is incorporated herewith.

Provenance of Resin

In the Annual Report of the School of Mines, Ballarat, for 1894, F. M. Krause reported the receipt of specimens of wood and retinite from the Madam Berry West Company shaft, Smeaton. It is believed that the specimen of resin here described may have been obtained from the same locality at the same time. Watson (1925) gives a short account of the specimen which is all that is now known with certainty as to its derivation. He says: "The Allendale specimen (of resin) came from the deep lead, where part of the formation consists of black clays in which logs still retaining their woody structure are occasionally found some 300 ft. below the surface and overlain by three flows of basalt."

Description of Resin Specimen

The weight of the lump of resin when it came into my hands was 34 lb. and it appeared to be practically complete except for a few small pieces previously removed. A lump weighing 9 lb. was broken off, having been selected as promising to yield fossils, the remaining portion being preserved intact.

Composition. J. C. Watson (1925) records the specimen herein described, as No. 681/22 "Clear resin with embedded leaves, deep lead, Allendale", and quotes analytical data and physical properties indicating the material to be retinite, $C_{11}H_{16}O_3$.

Specimens were submitted to the Sydney Technological Museum in 1945 and were reported on as follows:

"Melting Point Ca. 130°C .; S.G. 1.08; acid number, direct, mg KOH/g-128; saponification number, mg KOH/g-160; iodine number, Hubl, 20 hours-140; Liebermann-Storch test, rapidly fugitive purple; Halphen-Hicks test, permanent violet coloration; Benzoyl chloride test, deep brownish red colour; behaviour in butyl acetate solution under ultra-violet light, pale blue fluorescence. The resin belongs to the alcohol-soluble, hydro-carbon-insoluble class, and is comparable with the resins of *Callitris*, *Araucaria* and *Agathis* among the living Australian flora."

This result suggests that the specimen was derived from *Agathis*, the Kauri Pine, as leaves of this genus are embedded in it, as determined by Dr. R. T. Patton

(q.v. below). The structure of the specimen indicates clearly that it was derived from one large living tree.

Structure. The specimen has definite structures that permit a good deal to be inferred as to its origin.

- (a) Flow-layers. On the larger fracture surfaces it is seen that much of the mass is made up of a series of distinct flows of resin, each with a cloudy base full of wood-dust (doubtless derived from borers), the amount decreasing towards the top of each flow where the resin is clear. The flows are of considerable volume (Pl. III, fig. 2) approximating an inch thick for the most part, and thus indicating that the tree possessed reservoirs of resin, which from time to time were tapped by borers or flowed at certain times after having been previously bored into.
- (b) Resin drips. Much of the outside, and especially the apex of the lump is composed of numerous small separate drips of resin averaging a few inches in length and indicating, by their rounded fronts, the lower side of the lump (Pl. III, fig. 1.).

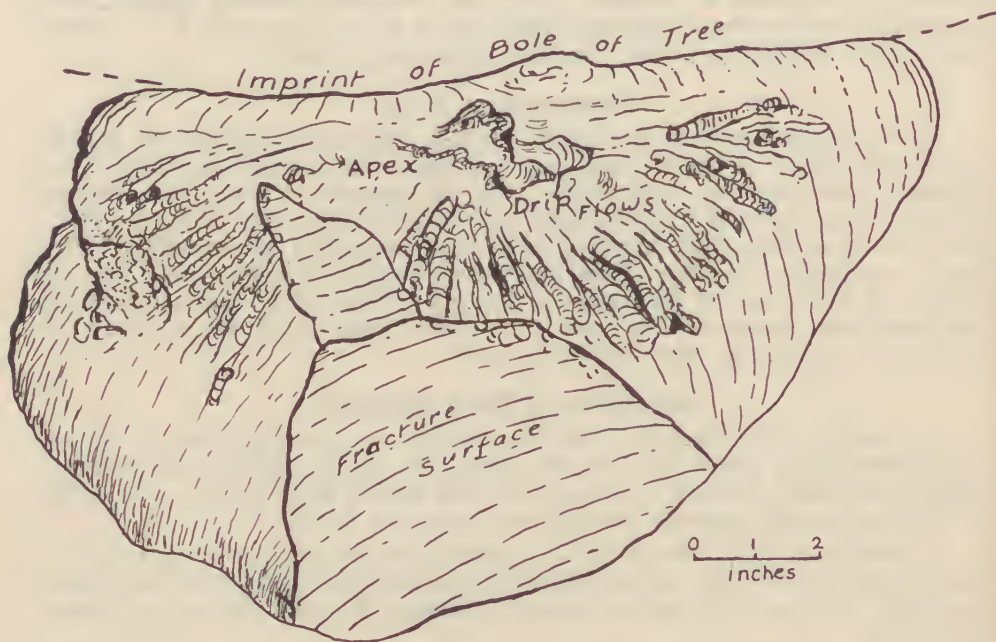


FIG. 1

When the specimen is orientated accordingly, one side is seen to be nearly vertical, relatively smooth, and gently curved in a vertical plane, no doubt constituting an impression of the bole of what must have been a tree several feet in diameter at ground level. At the apex of the specimen, which is well defined, the resin drips flowed downwards and outwards so that the lump has a general conical shape.

Fossils. The 9 lb. fragment was detached from the large lump near the base. It was broken up into pieces small enough to be transparent under a beam of light, and was examined and prepared by Mr. F. Hallgarten, who extracted the fossils by cutting the resin with a hot wire. In this way several fossils were obtained, which have subsequently been reported on by the under-mentioned persons, whose assistance is gratefully acknowledged:

Plants—Dr. R. T. Patton; spider—Professor V. V. Hickman; millepedes—Professor O. W. Tiegs; mite—Mr. H. Womersley; beetles and hymenoptera—Mr. C. Oke. Dr. F. H. Drummond also assisted in the preparation of zoological material for microscopic examination.

Not all of the fossils obtained were in a state of preservation sufficiently good to warrant their determination in the style currently used for living material, although in general the preservation is as good as or better than that of insects in Baltic amber. The list is as follows:

PLANTAE

1. *Agathis* material. Green leaf described in an accompanying paper by Dr. R. T. Patton.
2. (?) Genus. Broad dicotyledonous leaf.

ANIMALIA

Class DIPLOPODA (Millipedes)—*Spirobolus* (?) sp.

Class ACARINA (Mites)—*Acronothrus ramus* n.sp.

Class ARANEIDA (Spiders)—*Ariadna resinae* n.sp.

Order COLEOPTERA (Beetles)

Family PSELAPHIDAE—*Eupines setifera* n.sp.

Family TENEBRIONIDAE—*Platycilibe brevis* Cart.

Family SCYMAENIDAE (?) Genus

Subfamily CRYPTOHYCHINAE (?) Genus

Order HYMENOPTERA

Family FORMICIDAE (ants)—*Ponera scitula* Clark

Iridomyrmex sp.

(?) Family BELYTIDAE

Ecological Conditions

The fossils all indicate moist climatic conditions. *Agathis* today is restricted to tropical and sub-tropical regions and the tree that gave rise to the resin was clearly large and well-grown. Millipedes are the commonest animal fossils, according with a damp environment; the mite belong to a family inhabiting moss or humus, and the Coleoptera and Hymenoptera are all types that are to be expected in decaying vegetable matter, especially in logs, in a wooded moist environment.

Thus, despite the presence of living species of insects, which might indicate a very young geological age, the climate of the district was very different from that of today. *Agathis* is perhaps the best climatic indicator among the fossils. Its present distribution in Australia and New Zealand is tropical and sub-tropical.

Geological Age

The age of the Newer Volcanic basalts beneath which the resin specimen was found is presumed to range, at various localities, from mid-Pliocene to Holocene,

and the flows about Allendale are not among the youngest of the volcanic suite. They might reasonably therefore be regarded as Pliocene or Pleistocene.

On the other hand, the sub-basaltic fluviatile and lacustrine deposits, including the auriferous gravels, are not only older than the basalts but may in places be considerably older. *A priori* one can be no more specific with regard to the geological field evidence than to say that the resin was got from Tertiary or perhaps from Pleistocene lake or river deposits.

In the Tertiary floras, as currently known, *Agathis* is common in the brown coal measures, which are Palaeogene, and probably chiefly Oligocene. It has not been reported from the Neogene or Pleistocene, but in fact there has been little opportunity to undertake careful research on the younger Cainozoic floras. Where accurate determination of fossil wood has been carried out, e.g. from the sub-basaltic leads at Ballarat and from the Stony Creek Basin at Daylesford, conifers have been recognized, but these are undoubtedly not *Agathis*. They are either *Dacrydium* or *Phyllocladus* (the woods of which are very similar), suggesting a cooler climate. Again, however, the Yallourn coals contain these latter genera as well as *Agathis*, so that inferences as to climate, except with regard to the indications of humid conditions, are apparently difficult to draw.

The preservation of chlorophyll in the *Agathis* leaf, and the lack of oxidation of the resin except around the outside, suggest a younger rather than an older age. So also, the presence of living species of Coleoptera and Hymenoptera is an indication of youth, though no more than an indication. The only other fossils that may have some bearing on the question are *Pallimnarchus pollens*, a crocodilian obtained in a nearby mine from gravels in the deep leads, and *Crocodylus porosus*, from the Loddon valley. These are undoubtedly late Cainozoic yet sub-basaltic, and indicative of warm humid conditions in northern Victoria.

I believe, therefore, that the indications are sufficient to suggest that the resin is also late Cainozoic, and therefore that *Agathis* persisted, if only locally, in Victoria from the Lower to the Upper Cainozoic.

APPENDIX I

GREEN LEAF FROM FOSSIL RESIN, ALLENDALE, VICTORIA

By R. T. PATTON

Agathis yallournensis Cookson et Duigan. (Pl. IV, figs. 1, 2; Pl. V, fig. 1.)

The leaf, imbedded in the block of kauri-gum, was still green, although the chlorophyll was slightly yellowish, and the texture was very similar to the fresh material. The first sections were cut by hand. The preservation of the chlorophyll was a very remarkable feature.

In the breaking of the block, portions of the leaf were broken off so that complete measurements of it were impossible but it was estimated that the leaf was approximately 10 cm. long and 1 cm. broad. The leaf was lanceolate and had an entire margin.

Anatomy

(a) SURFACE VIEW

Upper epidermis. Cells polygonal, irregular in size and shape and ranging from triangular to hexagonal. In some parts the cells are arranged in irregular longitudinal rows but mostly the arrangement is wholly irregular. Thickness of walls $6/\mu$.

Lower epidermis. Stomata either in short irregular longitudinal rows or scattered. Axis very variable but the majority oblique. Stomata surrounded by several small cells, mostly four but up to six. Stomata $27/\mu$ in length. Other epidermal cells very irregular in size and shape. Walls very much thinner than those of the upper epidermis, $3/\mu$.

(b) CROSS SECTION

Upper epidermis. Cuticle conspicuously thick $6-9/\mu$, cells rectangular up to twice as long as broad. Hypodermis, one layer, cells elliptical. At times sclereides replaces the ordinary cells. Below the hypodermis is a discontinuous layer of sclereides.

Lower epidermis and hypodermis similar to those of the upper surface. Stomata at the base of pits formed partly by the depression of the guard cells and partly by the projection of the walls of the subsidiary cells beyond the epidermis. The projecting walls are surrounded by the cuticle.

Mesophyll. Vascular bundles conspicuous with strongly developed thickened fibres above and below. Bundles spaced at an average distance of $\cdot 35$ mm. Strongly developed irregularly branching sclereides are prominent. Secretory canals present.

Discussion

The genus *Agathis* Dallimore and Jackson (1948) has a fairly extensive range extending in an arc from Malay Peninsula through Borneo, Celebes Is., New Caledonia to New Zealand. On the Pacific Ocean side of the arc the genus occurs in the Phillipine Is., Solomon Is. and Fiji Is. On the continental side of the arc are two species in Queensland. All of the species with the exception of the one in New Zealand are tropical. The species in New Zealand occur in the extreme north of the North Island and may be regarded as a relic.

The wood of species of *Agathis* so far examined shows indefinite rings of growth and this character is also shown by specimens of *Agathis* from Yallourn brown coal. Associated with the *Agathis* wood at Yallourn is another wood which has very sharply defined rings of growth, as distinct as the rings of the woods of *Dacrydium* and *Phyllocladus* in Tasmania today (Patton 1927). Similar wood to that with the well-defined rings at Yallourn has been found at Ballarat and other places (Patton 1928) and this is now referred to the genus *Phyllocladoxylon*. As the present paper shows that *Agathis* was present in the deep leads, it may be assumed that it grew there and that therefore woods with sharply defined and ill-defined rings were both present in the leads.

Bibliography

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APPENDIX II

REPORT ON MILLIPEDES FROM FOSSIL RESIN,
ALLENDALE, VICTORIA

By O. W. TIEGS

Spirobolus (?) sp.

The material consists of one specimen measuring some 4 cm. in length, and of numerous small fragments.

In the best specimens, some 39 or 40 segments can be counted, and in places the legs are visible. This I have left intact in the resin.

A second specimen, showing the head and some anterior segments have been dissolved out of the resin with alcohol. A photograph of the head showing ocelli is given herewith; a second photograph shows the gnathochilarium in ventral view (Pl. V, figs. 2, 3).

The general features are consistent with assigning the specimen to the common genus *Spirobolus*; but it is necessary to emphasize that minute diagnostic features whereby modern taxonomy distinguishes *Spirobolus* from related, less common, genera, cannot be made out on the material, so that its precise identification remains uncertain.

Explanation of Plates

PLATE III

Fig. 1.—Resin lump from deep lead, Allendale, showing drip-structure and orientation of specimen.

Fig. 2.—Part of fractured surface of resin, showing several flow-layers.

PLATE IV

Agathis yallournensis

Fig. 1.—(A) Cuticle,
(B) Thickened fibres below the vascular bundle,
(C) Secretory canal,
(D) Portion of a branching sclereide.

Fig. 2.—Vascular bundle and thickened fibres.

PLATE V

Fig. 1.—*Agathis yallournensis*. Lower epidermis.

Fig. 2.—*Spirobolus* (?) sp. Head showing ocelli.

Fig. 3.—Head showing gnathochilarium in ventral view.